

Other BC albedo effects snow measurements

Ideas and preliminary results from an ongoing Norwegian project on Black Carbon

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Thanks to:

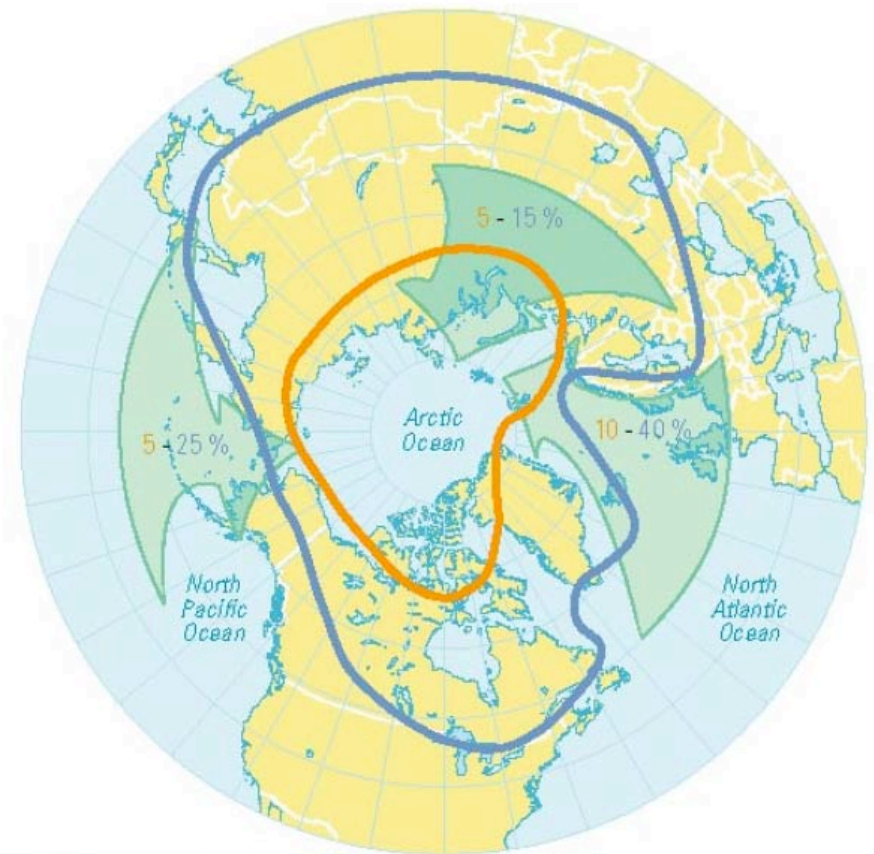
Sebastian Gerland and Christina Pedersen (NPI)

Johan Strøm (University of Stockholm, Sweden)

Ragnhild Skeie and Kristin Rypdal (CICERO)

Arctic Monitoring and Assessment Programme

AMAP Assessment Report: Arctic Pollution Issues, Figure 3-4



Arctic Front Winter
Arctic Front Summer

Major south to north air transport routes into the Arctic

AMAP

Planned measurements
in 2007

Measurements of snow albedo (NPI)



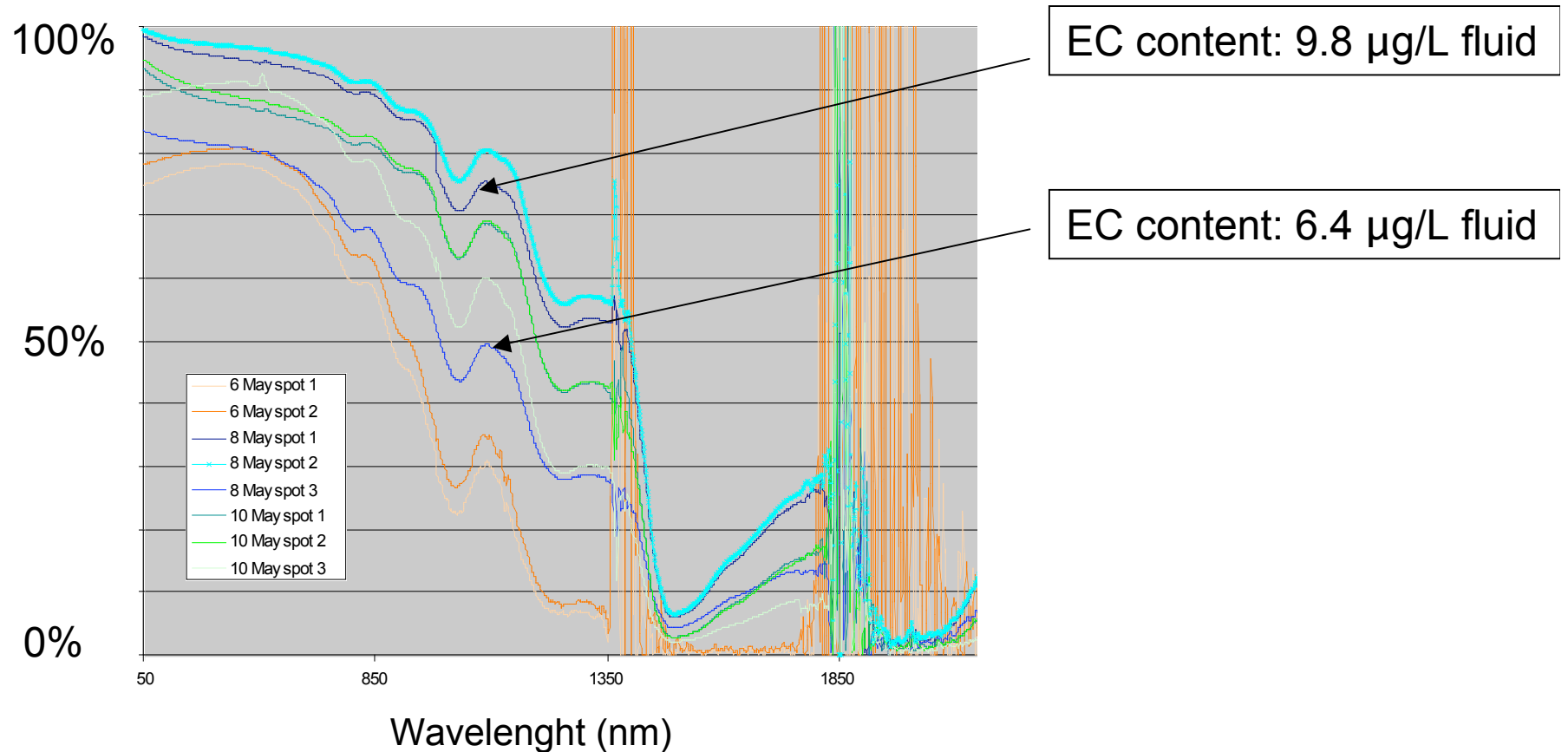
- The optical surface properties of snow surfaces (spectral albedo and reflectance) are measured with advanced spectroradiometers (ASD fieldspec and fieldspec pro, TriOS Ramses VIS)
- Ranges from 320 to 2500 nm with a spectral resolution in the 1 nm range

Chemical analysis of EC content in the snow



Chemical analysis of EC content on the quartz filters is done by Professor Johan Strøm's group (University of Stockholm, Sweden) using the so-called thermo-optical method (e.g. Chow et al. (*Aeros. Sci. Tech.*, 34: 23-34, 2001)).

Reflectance and EC measurements in snow in Ny Ålesund May 2006



Impact of snow properties



- High reflectance
- Higher EC content (9.8 $\mu\text{g/L}$ fluid)



- Lower reflectance
- Lower EC content (6.4 $\mu\text{g/L}$ fluid)

Interaction models/measurements

Measurements (snow reflectance, snow properties and EC content) provide:

- Indications of magnitude of overall climate impact
- Indicate trends in deposition of BC
- Data for validation of models
- Data for improvement of parameterizations in models

Models provide:

- Complete geographical and temporal coverage
 - EC content in snow (e.g. in ng(EC)/g(snow))
 - Inferred albedo change (e.g. SNICAR (Flanner and Zender, 2005))
- Impact on climate and climate change predictions (globally and regionally)
- Can be used to assess how various mitigation options affects climate

Transport of BC to high latitudes

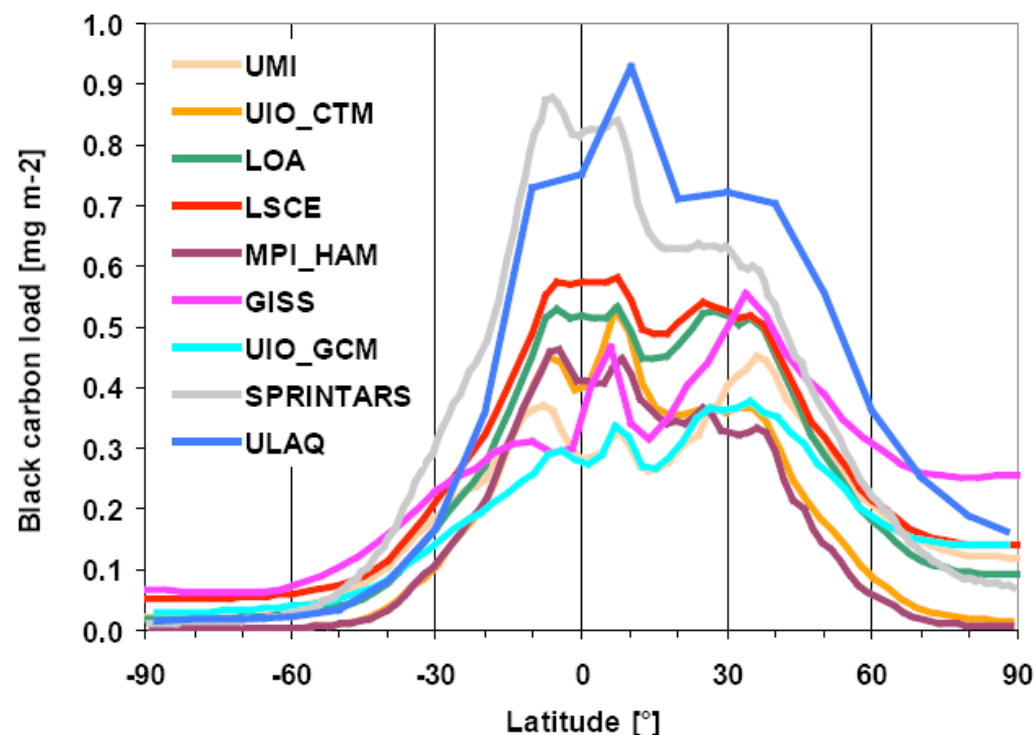


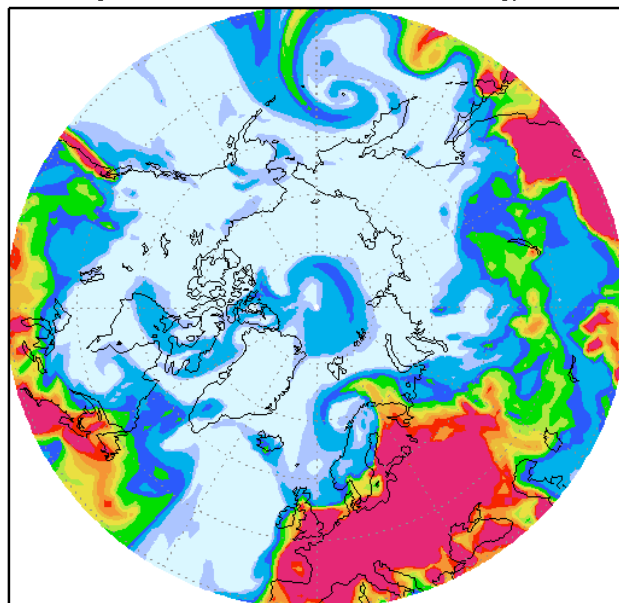
Fig. 1. Zonal distribution of the atmospheric load of black carbon for the AEROCOM B (present-day emissions) simulation.

Radiative forcing by aerosols as derived from the AeroCom present-day and pre-industrial simulations

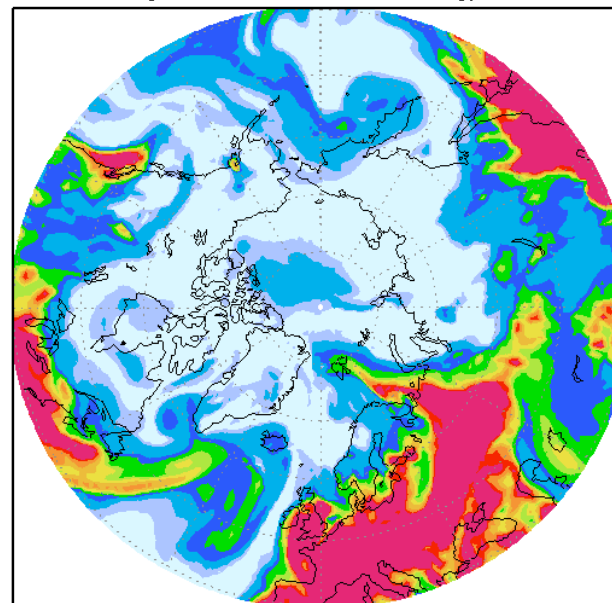
M. Schulz¹, C. Textor¹, S. Kinne², Y. Balkanski¹, S. Bauer³, T. Berntsen⁴, T. Berglen⁴, O. Boucher^{5,11}, F. Dentener⁶, S. Guibert¹, I. S. A. Isaksen⁴, T. Iversen⁴, D. Koch³, A. Kirkevåg⁴, X. Liu^{7,12}, V. Montanaro⁸, G. Myhre⁴, J. E. Penner⁷, G. Pitari⁸, S. Reddy⁹, Ø. Seland⁴, P. Stier², and T. Takemura¹⁰

Atmos. Chem. Phys., 6, 5225–5246, 2006
www.atmos-chem-phys.net/6/5225/2006/
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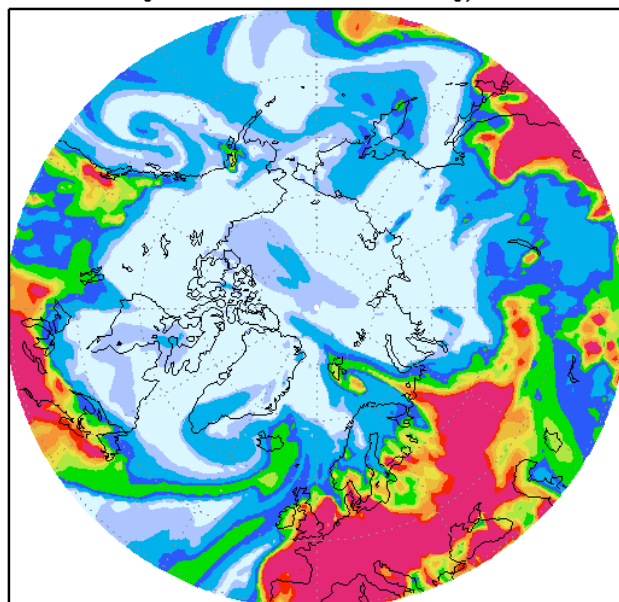
Dag 100 Lev 5 2004 BC tot ng/m3



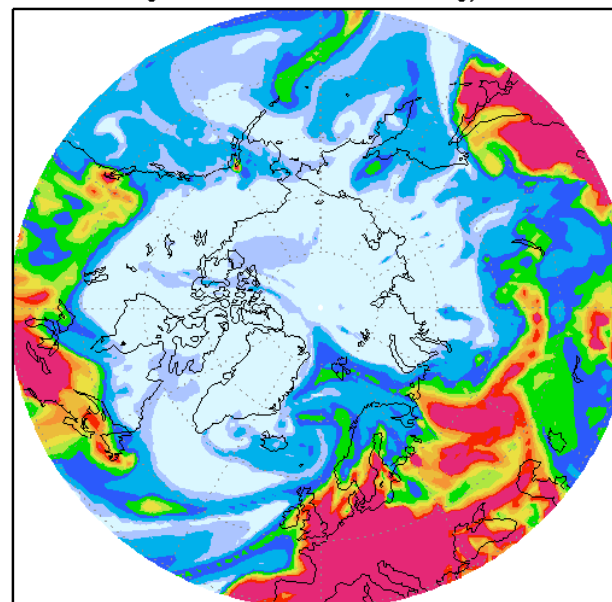
Dag 102 2004 BC tot ng/m3



Dag 103 2004 BC tot ng/m3



Dag 104 2004 BC tot ng/m3



Coupled effects, SO_4 – BC at high latitudes

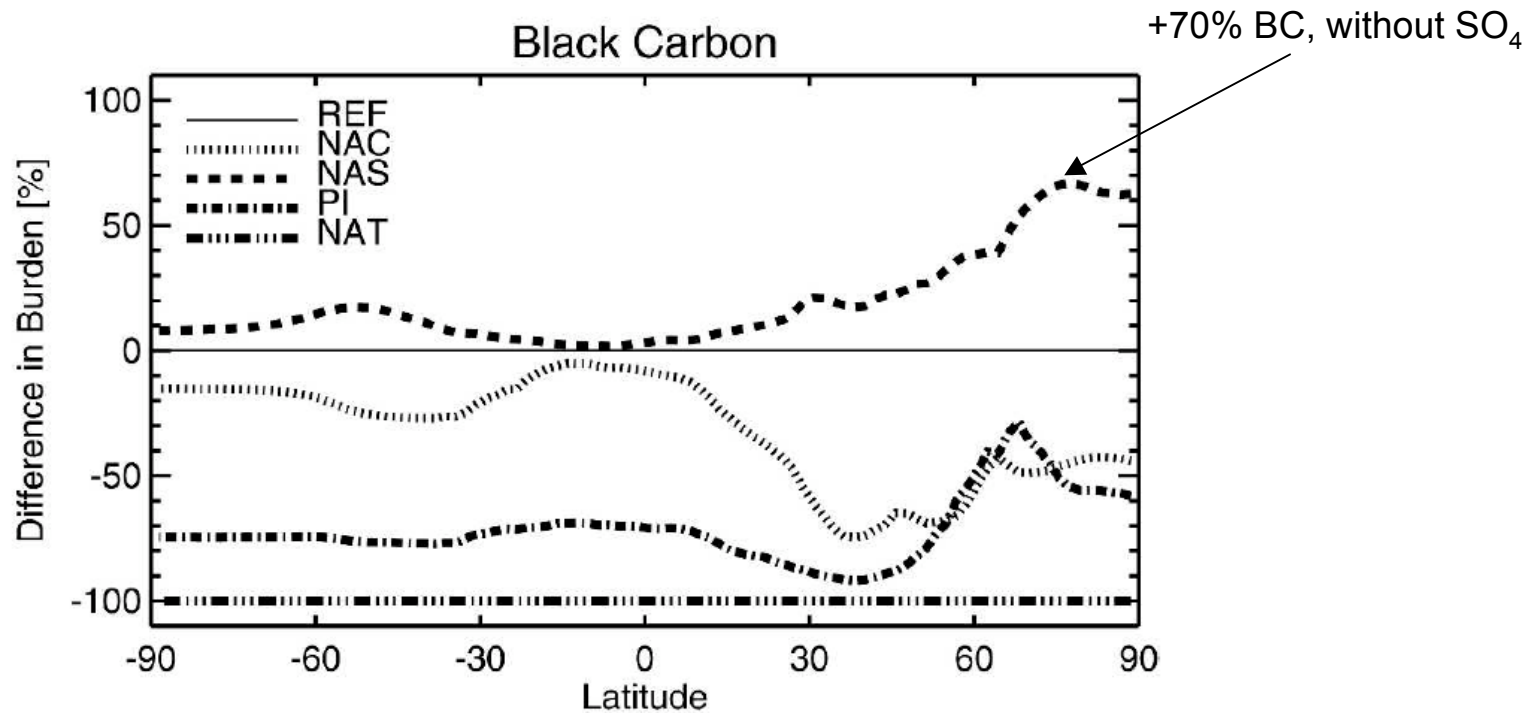


FIG. 2. Annual zonal-mean aerosol column burdens in $[\text{Tg}]$ and $[\text{Tg}(\text{S})]$ and the percent changes with respect to REF for NAT, PI, NAS, and NAC.

Emission-Induced Nonlinearities in the Global Aerosol System: Results from the ECHAM5-HAM Aerosol-Climate Model

PHILIP STIER,* JOHANN FEICHTER, AND SILVIA KLOSTER

Max Planck Institute for Meteorology, Hamburg, Germany

Plans for 2007 and 2008:

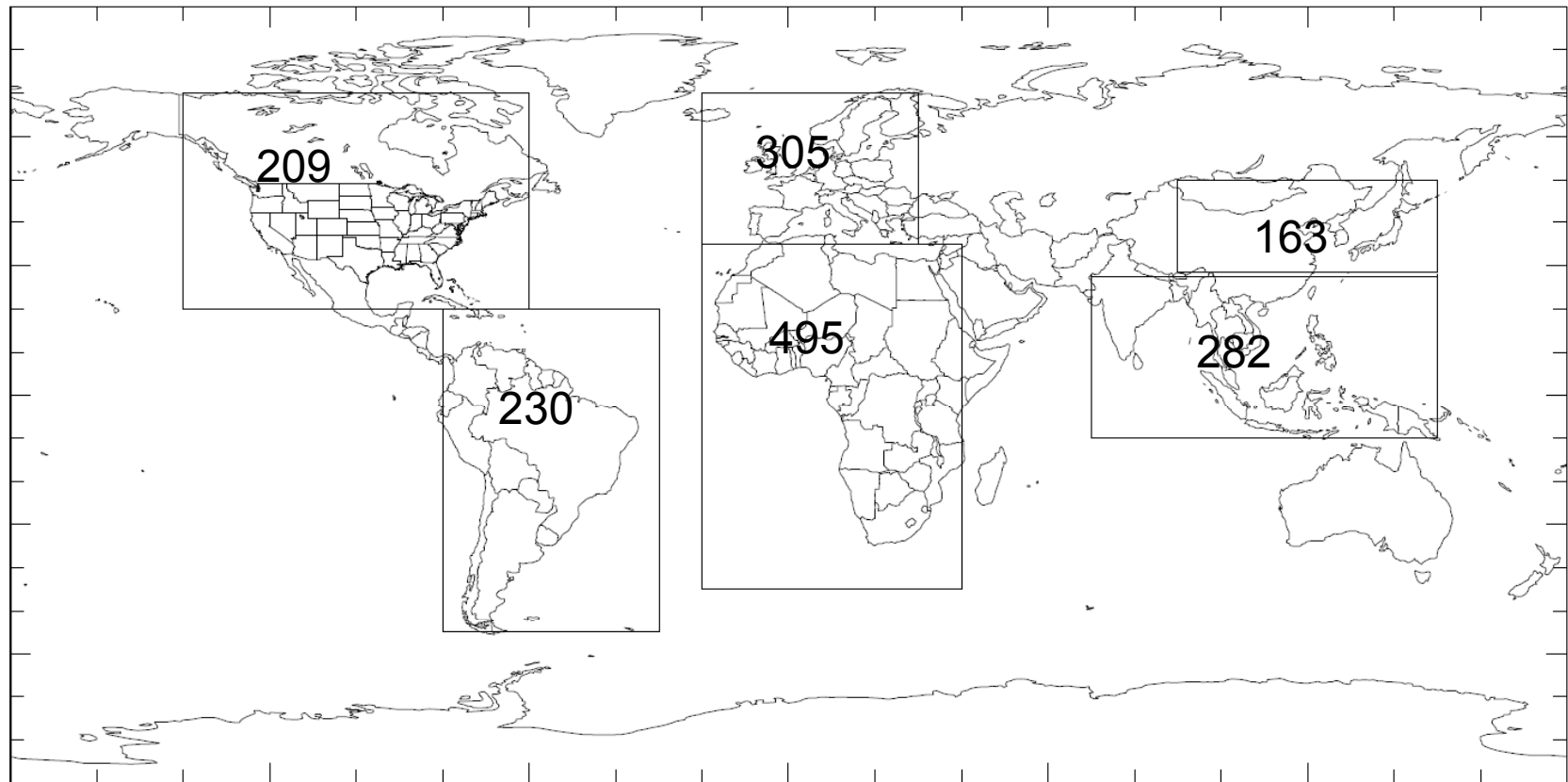
Intercomparison campaigns together with Steve Warren and co-workers

- Snow sampling and spectral albedo measurements at Ny Ålesund, Svalbard, Spring 2007 and at Barrow spring 2008
- Filter analysis for EC/BC content at respective home labs
- Modeling of BC transport, deposition and radiative forcing (direct and snow albedo effects)

Effective strategies to reduce BC emissions

- Where is the climate effect is the largest?

Regional GWP_{100} for BC from fossil fuels, direct effect only

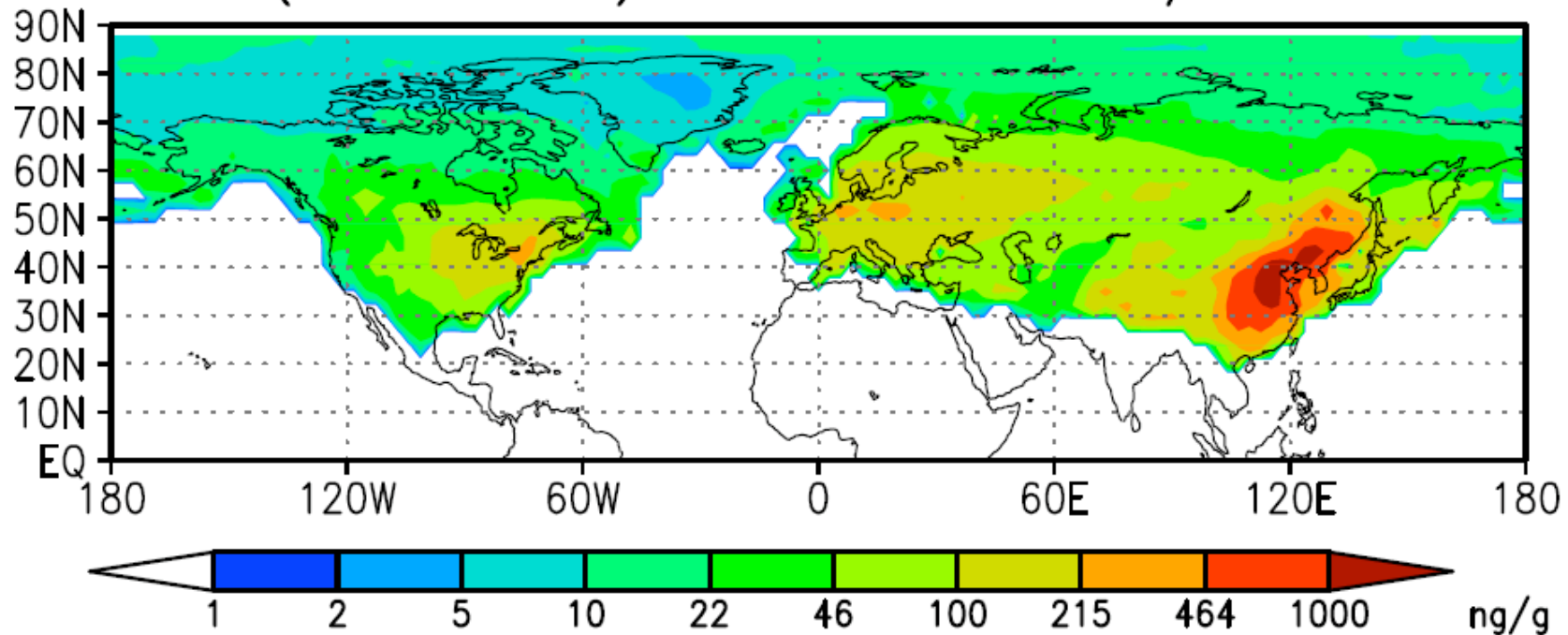


Effective strategies to reduce BC emissions

- Where is the climate effect is the largest?
 - Use Maximum Feasible Reduction scenario in 2030 as a cap
- Add considerations of costs
 - Where RF reduced per \$ is the highest
- Add consideration of fairness: who are able to pay
 - Weigh abatement effort by GDP/capita

What transport models predicts

1998 (FF+BF+BB) Annual Mean BC/Snow Conc.



Present day climate forcing and response from black carbon in snow

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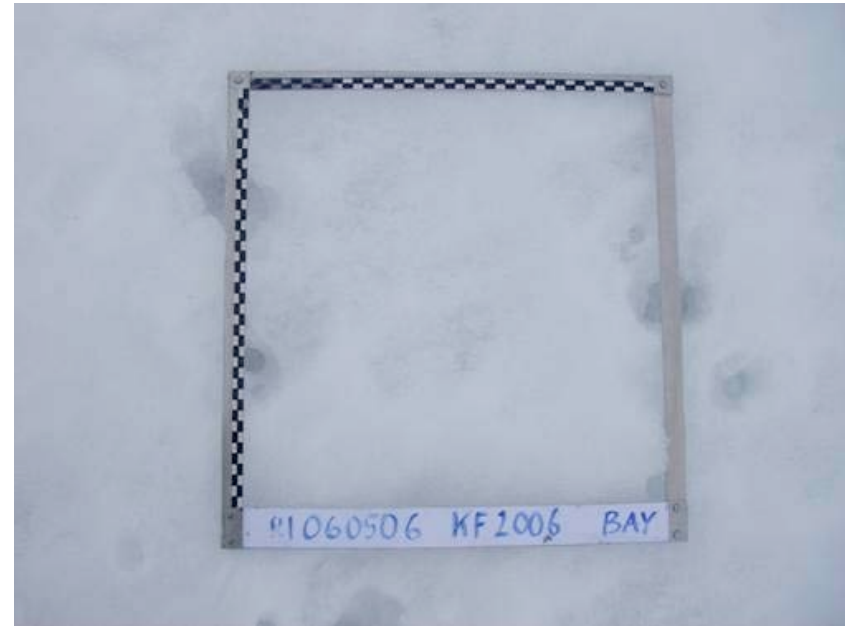
New dimension to climate policy

In 2005, the European Union stated that:

“the global annual mean surface temperature increase should not exceed 2 deg C above pre-industrial levels”

www.europa.eu/bulletin/en/200503/i1010.htm

Max/Min reflectance



Modern cars (approx. EURO V) with DPF

